Desired and Actual Labour Supply of Unmarried Men and Women in the Netherlands

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Abstract

Micro-econometric models explaining desired and actual hours of work of unmarried adults are analyzed. A discrete structural neoclassical model is used to explain desired hours. Desired hours depend on gross wage rates, tax and benefit rules, other income, and some background variables. The model takes account of fixed costs of working and of prediction errors in wage rates of nonworkers.

Actual hours are explained from desired hours and hours restrictions. Deviations between actual and desired hours are used to identify equations for involuntary unemployment and the availability of part-time jobs. Explanatory variables include age, education level, and the difference between potential earnings and some reference (minimum) wage.

The model is estimated using cross-section data from the October 1988 wave of the Dutch Socio-Economic Panel. We find larger wage elasticities of desired hours of work for females than for males. People with potential earnings below the reference wage have a significantly larger probability of involuntary unemployment than others. Apart from involuntary unemployment, the lack of part-time jobs appears to be an important source of hours restrictions.

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1. Introduction

In the empirical literature on labour supply, it is often assumed that actual hours of work purely reflect a labour supply decision. To make this consistent with micro-economic theory, it has to be assumed that individuals can freely and without costs choose their number of working hours, taking the corresponding wage as given. Actual labour supply would then be equal to desired labour supply. In practice, however, individuals are restricted in their choice. Due to, for example, imperfect mobility, incomplete information, or employer side restrictions, they may not be able to choose their optimal number of working hours. As a consequence, models in which it is assumed that actual labour supply is determined by preferences only, can be misspecified and may produce biased estimates of labour supply elasticities.

Blundell et al. (1987) estimate a model in which involuntary unemployment is explicitly incorporated. In this model, individuals are either involuntary unemployed, or can freely choose their number of hours worked. The standard model is strongly rejected against this double hurdle model. Dickens and Lundberg (1993) and Tummers and Woittiez (1991) compare predicted hours distributions of a standard model with the actual hours distributions and observe a poor fit. They claim that restrictions are important for actual labour supply. In both articles, a better fit is obtained by modelling the probability that an individual gets a job offer with a certain number of working hours. However, no structural explanation for the job offers or restrictions is given. In these three articles, information on the actual number of working hours is used, but not on desired hours, search behaviour, or restrictions.

Information on desired labour supply can be combined with information on actual hours to identify hours restrictions. See, for example, Ilmakunnas and Pudney (1990). They allow for three labour market states: non-participation, part-time work and full-time work. By comparing desired and actual states of individuals, they identify the probabilities of full-time and part-time job offers. They conclude that restrictions have a significant effect and claim that the standard model leads to an upward bias in the wage elasticity.

In this paper, we present a structural neoclassical model of labour supply and use information on both desired and actual labour supply to disentangle the effects of preferences and restrictions. Compared to Ilmakunnas and Pudney (1990), the information we use is more detailed: it is known how many hours each individual would like to work and how many hours he or she actually works. An important assumption in the analysis is that individuals' answers to the desired hours question only reflect preferences and are not affected by the restrictions. Moreover, individuals are assumed to be aware of the consequences of the different opportunities. In particular, they are assumed to know the exact after tax income for each possible choice.

The assumption that desired hours are not affected by restrictions makes the model recursive: information on desired labour supply is used to estimate preferences, i.e. a direct utility function in terms of leisure and income. Desired hours are those for which utility is maximized, given the budget constraint. The construction of the budget set incorporates the main features of the Dutch tax and social security system. Instead of working with the complete budget curve, we use a finite subset of it, following the discrete choice approach of Van Soest (1995).

Apart from desired hours, the result of the interaction between demand and supply is observed: actual labour supply. Confronting this with desired labour supply, makes it possible to analyze restrictions. We model these restrictions conditional on demographic, educational and regional factors, and productivity. The latter is of special interest because the Dutch minimum wage legislation and minimum wages in collective bargaining agreements (CAO-s) may lead to productivity thresholds: those with productivity below their threshold may less easily find a job because they are too expensive for the firms. The effect is that they have a larger probability of coping with restrictions than those with productivity above the threshold (see Meyer and Wise, 1983, for example).

Our models can be used for policy simulations. In contrast to the more traditional models based on actual labour supply, it is possible to disentangle the effects on preferred and actual employment. Policy measures concerning taxes and benefits will directly affect desired hours. Confronting the changed desired hours with the hours restrictions then leads to effects on employment and on actual hours worked. In contrast, policy with respect to labour costs or minimum wages affects the restrictions directly. The effect on employment is more difficult to analyze because it requires an assumption on the extent to which changing minimum wages affects actual wages and therefore also desired hours.

Most studies in this field focus on married or cohabiting females or couples, particularly in the Netherlands (see Grift, 1993, for a recent overview of Dutch studies). In this paper we focus on unmarried (and non-cohabiting) individuals, who can be seen as single decision makers. We distinguish six groups: single men and women, single mothers and fathers living with one or more children, and other men and women, mainly children living with their parent(s). If the results are to be used in a simulation model of the complete labour market, they can be combined with existing results for married couples.[2]

Some characteristics of the data, drawn from the Dutch Socio-Economic Panel 1988, are given in section 2. Section 3 handles the model of preferences and section 4 explains the way in which the restrictions are modelled. Section 5 gives simulations of the complete model. Section 6 concludes and compares the results with those based upon actual hours only.

2. Data

The data are drawn from the October 1988 wave of the Dutch Socio-Economic Panel (SEP), collected by Statistics Netherlands. We are interested in potential labour market participants, so we select the individuals older than 15 and younger than 65 years. We exclude those attending full-time education, people in military service, disabled persons, and the early retired.[3] The sample consists of 662 males and 806 females. 81.7 percent of all males and 62.9 percent of all females have a paid job. Sample statistics are presented in Table 1. The sample consists of 275 single living males, 357 single females, 20 lone fathers, 195 lone mothers, and 367 male and 254 female other household members, mainly children living with their parents. The last group is largest for men, which explains the

[2] In MIMIC, the most important general equilibrium model used for policy analysis in the Netherlands, labour supply of female spouses is endogenous, while labour supply of male spouses and singles is kept exogenous (see Gelauff and Graafland, 1994). Endogenizing labour supply of the latter two categories is currently being considered.

[3] The sample selection is based upon survey questions on each person’s most important occupation, job search behaviour, and receipts of various types of benefits. Approximately 43.1 percent of all males and 31.8 percent of all females in the age group 16-64 of unmarried (and non-cohabiting) individuals are removed from the sample.

relatively young average age for males.

Actual hours worked per week include regular overtime only if overtime is paid for. For 0.9 percent of all males and 0.4 percent of all females, actual hours could not be computed, due to missing or implausible information. Gross hourly wage rates are computed from net weekly or monthly earnings and actual hours worked, using the inverse of the Dutch tax system.

Table 1: sample statistics

Variable	Men		Women	
gross hourly wage (Dfl)	19.97	(492)	17.94	(468)
actual working hours	32.28	(656)	21.30	(803)
desired working hours	35.98	(648)	23.53	(798)
single	0.42	(662)	0.44	(806)
single parent	0.03	(662)	0.24	(806)
other household member	0.55	(662)	0.32	(806)
age	28.80	(662)	35.09	(806)
education level 1 (primary school)	0.27	(662)	0.29	(806)
education level 2 (lower vocational)	0.29	(662)	0.27	(806)
education level 3 (intermediate)	0.30	(662)	0.31	(806)
education level 4 (higher vocational)	0.10	(662)	0.10	(806)
education level 5 (university)	0.04	(662)	0.03	(806)

note: numbers of observations in parentheses

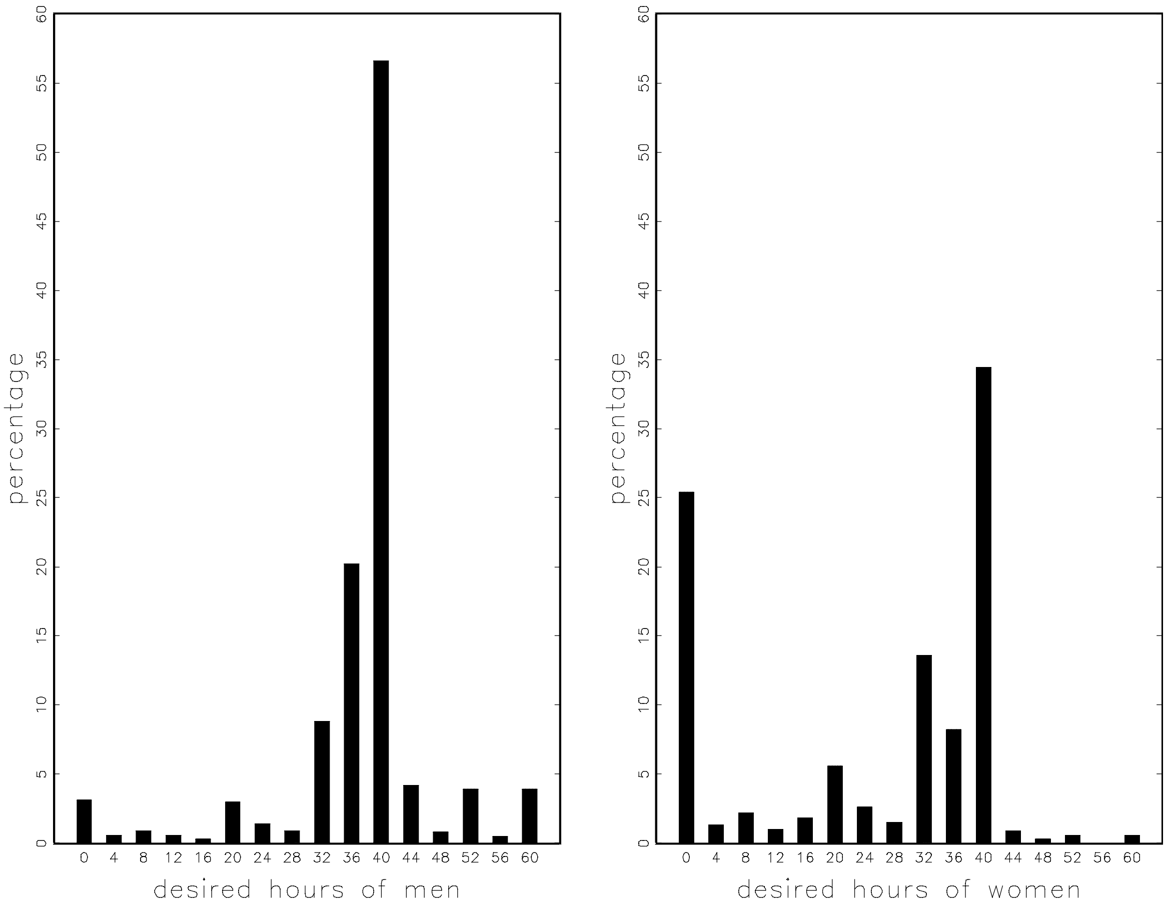
To distinguish preferences from restrictions, we use information on desired labour supply. Individuals with a paid job have answered the following questions:

> Are you satisfied with your number of working hours per week or would you like to work more or less? If you would like to work more or less, how many hours per week would you like to work then?

Individuals without a paid job are asked if they are searching for a job. Using some information on their search intensity, we categorized them as voluntary or involuntary unemployed. In the questionnaire the involuntary unemployed first have to answer how many hours per week they expect to work in a new job, and next how many they would like to work. We only use the latter:

> Suppose that you could choose freely your number of working hours in the new job. How many hours per week would you then like to work?
>
> *If you choose to work fewer hours than in the previous question, then you get less income. For working more, the reverse holds. Assume that other family members are not going to work more or less.*

Figure 1: desired hours distribution



In the questionnaires of the SEP from 1984 to 1986, the phrase in italics was also added to the desired hours question for working individuals. In 1987 it has been removed. Since we do not observe large differences in responses before and after the change of the question, we assume that the individuals still interpret the question in the sense that, when they choose to work less, they also earn less.

For 2.1 percent of males and 1.0 percent of females, desired hours could not be computed due to missing or implausible information on the relevant questions. Figure 1 shows the distribution of desired working hours per week. The majority of men prefers a full-time job (usually 38 or 40 hours per week). Only 3.1 percent of the men prefer not to work, while 25.4 percent of all women in the sample prefer not to work. In particular, 66 percent of lone mothers do not want a paid job. Our definition of desired hours neglects the fact that people without a job may not search any more because they have given up hope to find a job, i.e. the discouraged worker effect (see Blundell et al., 1987).

In section 4, we will identify labour market restrictions using differences between actual and desired hours of work. A first impression of these can be obtained from table 2. This table shows that there is substantial correlation between desired and actual working hours: most of the individuals are in the diagonal cells, implying that their actual and desired hours are similar. For men as well as women there is a concentration at the full-time working week (40 hours) for desired as well as actual hours. For women, the group of nonparticipants is almost as large, as was also clear from figure 1.

Table 2: desired and actual labour supply

Actual hours	Desired hours 0	8	16	24	32	40	48	56	Total
<u>men</u>									
0	**46**	3	1	7	7	49	0	0	113
8	0	**4**	0	1	0	2	0	0	7
16	0	0	**2**	1	0	3	0	0	6
24	0	0	0	**12**	2	5	1	0	20
32	0	0	1	0	**31**	15	0	0	47
40	0	1	0	3	32	**329**	8	1	374
48	0	0	0	1	4	8	**34**	0	47
56	0	0	0	0	0	1	2	**30**	33
Total	46	8	4	25	76	412	45	31	642
<u>women</u>									
0	**237**	6	3	12	8	31	0	0	297
8	0	**17**	1	1	1	6	0	0	26
16	1	0	**14**	2	4	7	0	0	28
24	0	1	1	**35**	5	8	0	0	50
32	0	0	0	1	**58**	8	0	0	67
40	0	0	1	8	44	**246**	0	0	299
48	0	0	0	0	4	5	**9**	0	18
56	0	0	0	0	1	5	0	**5**	11
Total	238	24	20	59	125	316	9	5	796

Explanation: desired hours, actual hours per week: 0: 0-3; 8: 4-11; 16: 12-19; 24: 20-27; 32: 28-35; 40: 36-43; 48: 44-51; 56: >= 52. Individuals whose actual or desired hours are not observed are not included in the table.

The restrictions revealed by this table work mainly in two ways. First, some individuals without work are looking for work. This is the case for 60 percent of men without work. (Note that the disabled and retired and those in full-time education are excluded from the sample.) The majority of them want a full-time job. Of the women without a paid job, only 20 percent is searching. Moreover, about half of the women looking for a job prefer a part-time job. The second type of restriction is that many of those with a full-time job would want to work fewer hours per week. The most obvious restriction seems to be on part-time jobs for about 32 hours per week; of the individuals who want such a job only a minority actually have one.

3. Preferences

The preferences of individuals are estimated using information on desired labour supply. It is assumed that desired labour supply represents preferences only, and is not influenced by existing restrictions in the labour market. The individuals weigh income[4] against leisure and choose desired working hours such that their utility is maximized.

Direct utility is specified as a function of the individual's leisure (ℓ) and net income (y). The utility function is chosen to be quadratic in logarithms:

$$U(v) = v'Av + b'v \qquad \text{where } v = (\log y, \log \ell)' \tag{1}$$

A is a symmetric 2x2 matrix with entries A_{ij} (i,j=1,2) and $b=(b_1,b_2)'$. We allow for preference variation across individuals through the parameter b_2, through observed individual characteristics x and a random preferences disturbance term ε^{rp}:

$$b_2 = x'\beta + \epsilon^{rp} \tag{2}$$

ε^{rp} is assumed to be normally distributed with mean zero and independent of explanatory variables and other error terms in the model (see below).

We assume that utility is maximized under a budget constraint: to each number of working hours corresponds a certain net income. To calculate this we make the additional assumption that the before tax hourly wage rate (w) does not vary with hours worked. Thus w and ℓ determine gross labour income, from which net income is computed by applying the (exogenously given) tax and social security system. We denote net income as the function $y=y(\ell,w,x)$, where x includes individual characteristics relevant for taxes and social benefits. To determine this function, the Dutch tax and social security system has to be modelled. The tax system in 1988 had of eleven brackets, with marginal rates from 0 to 70 percent. Due to lack of information on deductibles, health insurance premiums, etc., some approximations were necessary. We approximate the tax system using a log quadratic approximation, taking explicit account of the tax free allowance. See appendix B for details.

More difficulties arise with the social security system. The only features we take into account are child benefits ('Kinderbijslag') and Income Support ('Bijstand'). The amounts of child benefits are explicitly given in the SEP (some missing values were imputed). Income Support is provided when family income falls below the social minimum level. These are, however, means tested, except for older former employees and self-employed. We do not take this into account in our static framework, because in the long run, assets of non-workers will usually fall to zero.

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[4] The model is static, since income is used instead of total expenditures. A measure of savings could be used to correct income and make the model consistent with a life-cycle framework (as in Blundell and Walker, 1986). The available savings measure in the data, however, is based upon changes of asset holdings over time, implying that the correction could be inaccurate. We therefore did not carry it out.

Features of the social security system which we do not take into account are the Unemployment Insurance (NWW), Inability Insurance (WAO) and Early Retirement Scheme (VUT). The Unemployment Insurance gives a wage related benefit for a period depending on past employment. Again, because we consider our model as a kind of long term equilibrium, we neglect this benefit scheme. Another argument is that this benefit is not relevant for the choice not to work, because the worker has to loose the job involuntarily to be eligible. Both the Inability Insurance and the Early Retirement Scheme give an earnings related benefit until the age of retirement. We assume that these benefits are irrelevant for individuals who are active in the labour market. As explained in the previous section, disabled and retired people are excluded from the sample a priori. Very few individuals have a disability benefit and are either working or actively searching for work. These individuals are excluded, because their budget set cannot be determined.

In the standard continuous model (see, e.g., Hausman, 1985), the individual solves the problem:

$$\text{Max } U(y,\ell) \qquad \text{s.t. } y = y(\ell,w,x),\ \ell \le TE$$

where TE is the time endowment. This can be solved using Lagrange techniques. The complexity of the solution strongly depends on the nature of the tax and benefits rules, i.e. the form of the budget curve. Our approach is to replace the budget curve by a finite number of its points. The individual's problem can be rewritten as:

$$\text{Max } U(y,\ell) \qquad \text{s.t. } (y,\ell) \in CS(w,x) \tag{3}$$

where the choice set CS(w,x) is given by

$$CS(w,x) = \{(y,TE-h);\ h \in \{0,IL,...,(m-1)IL\},\ y = y(TE-h,w,x)\}$$

in which we define $h=TE-\ell$, the number of working hours per week. We only consider multiples of a fixed interval length IL for the working hours. The choice set contains m points. This implies that observed hours are rounded to a multiple of IL and censored at (m-1)IL. The choice set is denoted by $\{(y_0,\ell_0),...,(y_{m-1},\ell_{m-1})\}$.

Random error terms are added to the utilities of all choice opportunities in the same way as in the multinomial logit model:

$$u_j = U(y_j,\ell_j) + \epsilon_j \qquad (j=0,...,m-1) \tag{4}$$

We assume that the random errors ε_j are iid type I extreme value distributed, and independent of explanatory variables and other errors in the model. The ε_j can be interpreted as unobserved alternative specific utility components or errors in perception of the alternatives' utilities. They cannot be interpreted as random preferences due to unobserved family characteristics. Random preferences have already been incorporated in equation (2). The individual chooses j for which u_j is largest. The probability that j is chosen is given by:

$$\Pr[\ u_j \geq u_k \ \text{for all } k\ ] = \frac{\exp\{U(y_j,\ell_j)\}}{\sum_{k=0}^{m-1} \exp\{U(y_k,\ell_k)\}} \tag{5}$$

For all nonworkers and for about 8.5 percent of workers, the wage is unobserved. The best way to handle this problem would be to estimate a full model consisting of labour supply and wages. This is computationally burdensome, however. Therefore we estimate the wage equation separately, together with a reduced form selection equation to account for the fact that those with observed wages are not a random sample. The wage equation can be written as:

$$\log w = f(x,\mathbf{R};\gamma) + \epsilon^{w} \tag{6}$$

where x are the observed individual characteristics, R some reference (minimum) wage and ε^w is normally distributed with mean zero, independent of x and other errors in the structural model. See Appendix A for details. In the labour supply model estimates of this equation are used to replace unobserved wages by predictions. Because the prediction errors are often substantial, we take these errors explicitly into account in estimation.

The model described so far appears to underpredict nonparticipation and to overpredict the number of part-time jobs involving a few hours per week. An explanation might be (unobserved) fixed costs of working. Because we work with the direct utility function, these can be incorporated in a natural way: fixed costs (FC) have to be subtracted from the net income y for the strictly positive working hours. So instead of $U(y_j,\ell_j)$ this gives us $U(y_j\text{-}FC,\ell_j)$ for j=1,..,m-1. A slightly alternative specification, which is somewhat more convenient to work with, is to introduce fixed revenues FR of not working instead of fixed costs of working. This means that $U(y_0,\ell_0)$ is replaced by $U(y_0+FR,\ell_0)$. We specify the fixed revenues as follows.

$$\mathbf{FR} = x^{/}\delta + \epsilon^{fr} \tag{7}$$

Here ε^{fr} is normally distributed with mean zero and independent of the explanatory variables and of the other error terms in the model. If utility increases with income, positive fixed revenues increase the utility of not working, thereby increasing the probability of nonparticipation. The fixed revenues are fully incorporated in the structural model. Thus an increase in wages, for example, will lead to an increase in participation, because $U(y_j,\ell_j)$ will increase for j>0, while utility of not working remains unchanged.

Effects of wage, tax, or benefits changes on participation are thus be taken into account in the simulations. This is an important advantage compared to the model conditional upon participation.[5]

The standard model, without random preferences or fixed costs, can be estimated by maximum likelihood. For observed wages, the likelihood contribution follows from (5). For unobserved wages, the wage has to be integrated out using (6). As we also use random preferences and fixed costs, two additional error terms have to be integrated out. To avoid more dimensional numerical integration, we approximate the integral by a simulated mean. For each individual we take M drawings from the distribution of the error terms, and compute the average of the M likelihood values conditional on the drawn errors. This method is a special case of smooth simulated maximum likelihood. Provided that M tends to infinity at a fast enough rate with the number of observations, this method is asymptotically equivalent to maximum likelihood, see Gourieroux and Monfort (1993).

The probabilities in (5) are always well defined and positive, which is not changed by integrating out the conditional probabilities. Therefore, statistical coherency of the model is automatically guaranteed. In contrast to the continuous model, imposing Slutsky conditions (quasiconcavity of the direct utility function) is not necessary (see for instance Van Soest et al., 1993). Ex post, it can be checked whether the utility function is quasiconcave. If it is not, this does not affect the economic interpretation of the model, which does not rely on concavity. On the other hand, however, it could also happen that the estimated utility function is not increasing with net income. In that case, the model is still coherent in a statistical sense, but its economic interpretation would be lost. To prevent this from happening we add a penalty to the loglikelihood for observations at which the utility of a corresponding interior point of the budget set is higher than the utility of the point on the edge of the budget set.[6]

Results

Since desired and actual working hours per week are measured as discrete variables and vary from 0 to about 70, a natural choice for the interval length and number of points would be IL=1 and m=71. To limit the computational burden however, we choose IL=8 and m=18. Furthermore we use TE=112 and M=10. After presenting the results and simulations, we will do a sensitivity analysis to study the impact of the choices made. It will turn out that the results are not really affected by the choices of IL,m,TE and M. More important seems the weight α in the penalty. In table 3 we present the results for

[5] The fixed costs are a novelty compared to Van Soest (1995). There, the lack of part-time jobs is accounted for by adding disutilities to part-time jobs. The fixed costs approach has more structure and is less ad hoc.

[6] If no penalty is used, the coefficients of log y and $\log^2 y$ are estimated very inaccurately and utility decreases with income for some observations. The penalty function we use is:

$$\text{penalty}(j) = \log \Phi\left(\frac{U(y_j,\ell_j) - U(\tfrac{1}{2}y_j,\ell_j)}{\alpha} \right) \qquad (\alpha>0),\ j=0,\dots,m$$

with Φ the standard normal distribution function. α is a smoothness parameter; the larger α, the less important the penalty. We used α=2 in our final specification (see discussion under sensitivity analysis).

our basic model. The parameter for the variance of the random preferences converged to zero, so we set it equal to zero.

Table 3. Estimation results based on desired hours

	parameter	standard error
utility function (1)-(2)		
$\log^2(y)$	-1.12	0.20
$\log^2(TE-h)$	-45.16	1.78
log(y)*log(TE-h)	1.04	0.40
log(y)	10.41	4.85
log(TE-h)	442.35	39.79
log(TE-h)*single	2.51	1.24
log(TE-h)*lone parent	18.89	4.51
log(TE-h)*log(age)	-32.61	19.39
log(TE-h)*$\log^2$(age)	4.14	2.78
log(TE-h)*#children	-8.05	3.10
log(TE-h)*female	82.79	47.38
log(TE-h)*female*single	-1.57	1.74
log(TE-h)*female*l.parent	-11.39	5.00
log(TE-h)*female*log(age)	-59.22	27.58
log(TE-h)*female*$\log^2$(age)	10.84	3.98
log(TE-h)*female*#children	6.35	3.31
$\sigma(\varepsilon^{rp})$	0.00	
fixed revenues (7)		
constant	-3.82	0.87
education level	-0.06	0.02
single	-0.17	0.14
lone parent	-3.02	0.77
log(age)	1.48	0.29
#children	1.22	0.53
female	2.23	0.87
single*female	0.25	0.18
l.parent*female	2.76	0.80
log(age)*female	-0.84	0.28
#children*female	-1.04	0.54
child<6*female	0.73	0.15
$\sigma(\varepsilon^{fr})$	0.46	0.07

note: h is hours worked per week, y is net income in Dfl per week, #children is number of children younger than 18 and living at home, child<6 is dummy for children younger than 6.

The appreciation of leisure time depends on individual characteristics via the parameter b_2 (see (2)). A positive value means a positive correlation between the characteristic and the appreciation for leisure, and a negative influence on labour supply. Many parameter estimates are, however, difficult to interpret due to interactions. For instance, the single parent dummy and the number of children are strongly interrelated. We observe that there are some significant differences between males and females. Ceteris paribus, labour supply of males has a maximum at age 51. For females, the maximum is found at age 21.

Fixed revenues of not working are significant and positive for almost all individuals. This means that small numbers of working hours are often inferior to not working. The fixed revenues are significantly different between males and females. They increase with age. Fixed revenues may not only reflect purely financial costs of working. For example, the negative effect of education level may be due to a discouraged worker effect or larger search costs of those with low education, since for these people the probability of involuntary unemployment is larger than for others.

By differentiating with respect to income it can be shown that in the relevant part of the domain utility is an increasing function of net income. On the other hand, for 23 percent of males and 40 percent of females, utility is decreasing in leisure. This appears to happen for individuals who supply no or only few hours of labour, and is due to the introduction of the fixed revenues in the model. It does not harm the economic interpretation of the model.

Simulations

The sample is divided in three groups for both men and women: singles (2), single parents (3) and the remaining group (1), mainly children living with their parents. The first simulation in table 4 serves to compare the results of the model with the sample data. The model appears to reproduce the average numbers of desired hours and the participation rates quite well. This is mainly due to the introduction of fixed revenues. The table does not show that the model is not capable of predicting the spikes in the hours distribution at 40 hours per week, particularly for men. It underpredicts the number of men who want to work 40 hours a week, and overpredicts the numbers in the two adjacent hours categories.

In the second simulation, all before tax wage rates are increased by 10 percent. Comparing the results with those of the first simulation, we find that the effect on labour participation for males is modest. Because a vast majority of the males already supplied labour before the wage increase, a large effect could not be expected anyhow. The same holds for the group of females living with their parents. Larger effects are found for the groups of single females and single mothers. For all groups, average desired working hours increase, implying that the positive substitution effect of the wage increase dominates the negative income effect. The estimated own wage elasticity for lone mothers is about 0.81 (including effects on participation), for single women it is about 0.32. For the other groups, the elasticities are smaller.

In the third simulation, the Income Support is lowered by 10 percent. The effect on labour participation is slightly smaller than for the 10 percent wage increase, while the effect on average desired working hours is slightly larger than that of a wage increase.

Sensitivity analysis

As the base case we used IL=8, m=8, TE=112, M=10 and α=2. The choice of IL, m and M is a trade off between accuracy of the model and computational burden. The question is how sensitive the results are to this choice. We therefore reestimated the model with the same auxiliary parameter values but one. Some results are presented in Appendix C. All models capture participation rates and average hours worked to a similarly satisfactory extent.[7] It turns out that the wage and income support elasticities for IL=10, m=4, TE=98 and M=20 are of the same order as those for the basic model (in Table 4), so the main results are not affected by the choice of IL, m, TE and M. The choice of α is more problematic. The preferred value would be $\alpha=\infty$ (no penalty). For $\alpha=\infty$, utility is decreasing in income for about five percent of the men. $\alpha=2$ appears to be the highest α (with the smallest penalty) for which utility always increases with income. The choice of α has some effect on the elasticities. For instance, for $\alpha=5$ the elasticities are on average 30 percent larger then in the basic model, but for $\alpha=\infty$, they are smaller than for $\alpha=2$. For $\alpha=2$, the model performed well in terms of participation rate and labour supply compared to other values.

Table 4: Simulations of desired participation and desired hours of work

Group		Sample		Simulation 1 Basis		Simulation 2 Wage +10%		Simulation 3 Inc.Sup. -10%	
	men								
1	367	95.1%	37.8	94.9%	37.7	95.9%	38.2	95.8%	38.3
2	275	90.5%	34.9	90.3%	35.0	92.2%	35.6	91.9%	35.7
3	20	95.0%	31.6	94.4%	31.5	95.4%	32.0	95.3%	32.2
	women								
1	254	93.3%	34.6	92.8%	34.3	93.9%	34.9	93.8%	35.1
2	357	70.9%	24.1	70.3%	24.1	72.6%	24.8	72.6%	25.0
3	195	42.6%	10.7	43.0%	11.9	45.8%	12.8	45.5%	12.9

note: group 1: reference group, mainly children living with their parents; group 2: singles, group 3: single parents. Simulation 1: model with the actual wages and benefits; simulation 2: wages increased by 10%; simulation 3: Income Support lowered by 10%. First entry: desired participation rate (in %); second entry: average value of desired working hours per week.

4. Restrictions

Restrictions in the labour market are caused by an imperfect fit of demand and supply of labour. We do not observe labour demand directly, so we cannot estimate a complete structural model. By confronting desired labour supply with actual labour supply however, we are able to identify those who face restrictions among the individuals supplying labour. In this section we model, for each individual and each number of working hours h considered (h=0,8,..,56), the probability P(h) that the individual has the opportunity to

[7] The model tries to fit hours worked after classification into cells. As working hours are censored at 56 hours per week, the average after classification is too low. The model with IL=10 performs better in this respect (see table C.2).

work this number of hours.[8] Thus the probability that someone is restricted and cannot work h hours is equal to 1-P(h). If all probabilities P(h) are equal to one, then there are no restrictions. The probabilities P(h) can depend on the individual's productivity, the reference (minimum) wage, other individual characteristics, and on h itself. We specify P(h) as follows.

$$\mathbf{P}(h) \;=\; \psi_1(h)\;\;\psi_2(x,F,\mathbf{R}) \tag{9}$$

Here ψ_1 is a function with possible values between 0 and 1. We work with multiples of four hours per week and assume $\psi_1(8j)=\tau_j$, j=1,.,7, with τ_j parameters to be estimated.

The individual characteristics x, productivity F and the reference (minimum) wage R influence the probabilities P(h) through the function ψ_2. A consequence of the multiplicative specification of P(h) is that these variables influence the probabilities of different numbers of hours in the same way. We work with the following ψ_2.

$$\psi_2(x,F,\mathbf{R}) \;=\; \Phi(x'\beta + \delta\,\mathbf{g}(F-\mathbf{R})) \tag{10}$$

The reference wage R reflects the market minimum for an individual of certain age and education level. It may be influenced by the legal minimum wage and the minimum wages of collective bargaining agreements (CAO-s). The idea is that individuals with an expected productivity lower than this reference wage have a smaller probability to find a job and a larger probability of involuntary unemployment, because they are relatively expensive for the firms. This is modelled by the term g(F-R), which indicates whether productivity is smaller than the reference wage or not. It equals 1 if productivity is smaller than 95 percent of the reference wage, 0 if the productivity is larger than 105 percent of the reference wage and decreases continuously from 0 to 1 if productivity rises from 95 to 105 percent of the reference wage.[9] We expect that $\delta<0$. A problem is to find a reasonable way to determine the reference wage. Our procedure is explained in appendix A. There we also explain how we construct F, unobserved productivity, as a function of the reference wage and potential hourly earnings.

Besides the separate probabilities of jobs with different numbers of hours, we also need to model the relation between the different job opportunities. We allow them to be dependent by assuming a two stage process for the restrictions which is similar to the double hurdle model of Blundell et al. (1987). First of all, the individual characteristics determine if a person has entry to the labour market or not (probability determined by the function ψ_2). Secondly, given that the individual has entry, the possibilities to choose certain numbers of hours are determined independently from the individual characteristics

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[8] Following job search theory, it would be natural to see each job offer as a combination of hours and earnings. We retain the assumption in section 3 that each individual has a unique gross wage rate. Therefore job offers are completely characterized by working hours.

[9] g(F-R) is similar to a dummy with value one if F<R and 0 otherwise. We might just as well have used the dummy itself.

and from each other (the function ψ_1). Thus, for example, the probability that a person can choose to work both 24 and 40 hours is given by:

$$P(\{24,40\} \subset CS) = \psi_1(24)\ \psi_1(40)\ \psi_2(x,F,R)$$

The probability that a person can choose none of the numbers of hours (and is involuntary unemployed) is given by:

$$P(CS=\{0\}) = 1 - \psi_2(x,F,R) + \psi_2(x,F,R) \prod_{j=1}^{7} [1-\psi_1(8j)] \tag{11}$$

To estimate ß,δ, and $\tau_1,...,\tau_7$, we combine the information on actual and desired working hours. We estimate the parameters with ML, conditional on desired labour supply. The restrictions determine how actual working hours come about, given desired working hours. For example, if a person's desired and actual working hours are both equal to 40, then the likelihood contribution is simply P(40): we know that the individual was able to choose to work 40 hours per week. If a person is not working and also doesn't want to work, then there is no contribution to the likelihood. This person is not participating on the labour market, so we don't know if he or she would be confronted with restrictions.

More problematic is the case of an individual whose actual working hours are different from desired working hours. Take, for example someone who works 40 hours and would like to work 24 hours. It is clear that such a person does not have the opportunity to work 24 hours, and is able to choose 40 hours. It is not clear, however, which other opportunities he or she may have. For example, he or she would probably also prefer to work 32 hours instead of 40 hours.[10] The fact that he or she works 40 hours then reflects that the option of working 32 hours is not available. In principle, the model described in section 3, i.e. the budget set and the preferences of the individual, completely describes the ranking of all the alternatives. The largest utility in the choice set (CS) of an individual gives the actual working hours (h^a):

$$h^a = h_j \quad \text{if} \quad j = \arg\max_{j:(y_j,l_j)\in CS} U(y_j,l_j) + \epsilon_j$$

A problem is that the alternative specific errors ε_j in (4) are unobserved. Computation of the likelihood in a way consistent with the model of the previous section would require the computation of the probability that, for example, 32 hours is preferred to 40 hours, given that desired hours are equal to 24. To avoid the computational problems involved with this, we do not rely on the model in section 3 and make an ad hoc assumption

[10] A simple graph shows that this is certainly the case if utility is quasi-concave and the budget set is linear between 24 and 40 hours. If, however, 32 hours is near a kink point or if preferences are not quasi-concave, 40 hours may be more attractive than 32 hours, even though 24 hours is optimal.

instead: we assume that all possible numbers of hours which are closer to the desired number of hours (h^d) than the actual number of hours (h^a), would be preferred to h^a. This implies that individuals choose actual hours h^a as follows, conditional on desired hours h^d:

$$h^a = h_j \quad \text{if} \quad j = \arg\min_{j:(y_j,l_j)\in CS} \; | \, h - h^d \, | \tag{12}$$

The fact that actual hours are 40 while desired hours are 24 then reveals that 32 hours is not in the individual's choice set. In this example, not only the restriction on 24 hours, but also restrictions on 16 and 32 hours are therefore binding. Furthermore, we assume that, if the individual desires to work 24 hours but can only choose between 8 and 40 hours, these two alternatives are chosen with equal probability. This implies that the likelihood contribution in the example is given by

$$P(h^a\!=\!40 \,|\, h^d\!=\!24) = \{½ + ½(1-\psi_1(8))\}(1-\psi_1(16))(1-\psi_1(24))(1-\psi_1(32))\,\psi_1(40)\,\psi_2(x,F,\mathbf{R})$$

Table 5: Determinants of the probability of a job offer with given number of hours

	parameter	standard error
<u>individual characteristics</u>		
constant	3.81	0.62
log age	-0.70	0.19
education level	0.15	0.05
female	0.18	0.12
region north	-0.64	0.18
region east	-0.40	0.16
region south	-0.55	0.15
g(prod/ref.wage)	-1.00	0.22
<u>hours restrictions</u>		
8 hours	0.63	0.09
16 hours	0.47	0.06
24 hours	0.45	0.04
32 hours	0.42	0.03
40 hours	0.88	0.01
48 hours	0.51	0.05
56 hours	0.62	0.07

Results

Table 5 shows the estimates of equations (9) and (10). We include a dummy for sex (FEMALE: 1 if female, 0 if male) which is insignificant.[11] Thus, at least for this group of unmarried individuals, accessibility to jobs does not seem to be different between males and females. Education level has a significant positive effect on the probability of finding a job. Age has a significant negative effect. Individuals living in the western part of the Netherlands have a higher probability of a job offer than others. The effect of crossing the reference wage has the expected sign: when productivity falls below the reference wage, the probability of involuntary unemployment increases significantly.

The second part of table 5 gives the estimates of the parameters τ_j, j=1,...,7. As could be expected from table 3, part-time jobs are more difficult to find than full-time jobs. The large parameter value for τ_5 shows that persons who prefer a full-time job, are usually either able to obtain such a job, or involuntarily unemployed. This explains why it rarely happens that a person who prefers a full-time job, actually has a part-time job. The opposite happens much more frequently.

Simulations

The sample is divided in the same groups as in the previous section: singles (2), lone parents (3) and the remaining group (1). The first simulation in table 6 serves to compare the results of the model with the sample. The model predicts the participation rates for the different groups reasonably well, especially if it is taken into account that this model does not contain dummies for the groups as explanatory variables.

In the second simulation, all reference wages are decreased by 10 percent. This should have a strictly positive effect on actual participation, because we assume here that productivity and wages remain the same. If reference wages are decreased, fewer people will have productivity below the reference wage. For most groups, the employment rate increases by about one percent. An exception is the group of lone mothers whose employment rate would change by 1.1 percent-point, i.e. 3.3 percent.

Table 6: Simulations of actual participation and actual hours of work

Group		Sample		Simulation 1 Basis		Simulation 2 Ref. Wage -10%	
	men						
1	357	85.7%	34.2	85.5%	34.0	86.4%	34.3
2	271	79.0%	31.4	80.9%	31.5	81.6%	31.7
3	20	80.0%	26.4	75.2%	26.0	76.0%	26.3
	women						
1	253	84.2%	30.5	85.5%	32.2	86.5%	32.6
2	353	64.3%	22.9	63.8%	22.4	64.5%	22.7
3	192	33.9%	8.6	33.1%	9.5	34.2%	9.7

note: group 1: reference group, mainly children living with their parents; group 2: singles; group 3: single parents. Simulation 1: model with the actual wages and benefits; in simulation 2, reference wages are lowered by 10%. The first entry is the participation rate (in %), the second is average desired working hours per week.

[11] We also tried interaction terms of sex with other variables, but these turned out to be insignificant.

Note that in this simulation it is assumed that potential wages remain the same. If a decrease of the reference wage would cause a decrease in wages, the sign of the total effect becomes unclear, since supply and demand effects work in opposite directions. We take this into account in the next section.

5. Simulations

In this section we combine the labour supply model and the model of the restrictions to create a complete model for actual employment and hours worked. We do this by applying the restrictions to the output of the labour supply model. The complete model is convenient to analyze policy measures which have an effect on both the supply and demand side of the labour market. Table 7 shows some simulation results. Again the sample is divided into three groups: singles (2), single parents (3) and the remaining group (1). The first simulation is the reference case; it uses actual wages and benefits.

In simulation 2 Income Support is lowered by 10 percent. In section 3, we showed that this has a substantial impact on desired participation. We now find that reducing Income Support also leads to a substantial increase in the actual employment rate. There are two effects responsible for this. The obvious effect is that some individuals who preferred not to work, decide to participate in the new situation. The other effect of lowering the Income Support is that some individuals who wanted to work part-time and decided not to work because they were restricted in the sense that they could not find a part-time job, now decide to accept a full-time job.

Table 7: Simulations of actual participation and actual hours of work

Group		Simulation 1 Basis		Simulation 2 Inc.Sup. -10%		Simulation 3 Ref.wage -10%		Simulation 4 Both policies	
	men								
1	367	85.6%	34.0	86.4%	34.6	86.2%	34.3	87.1%	34.8
2	275	81.6%	31.8	83.0%	32.4	81.9%	32.0	83.3%	32.6
3	20	75.6%	26.1	76.3%	26.6	76.1%	26.3	76.9%	26.8
	women								
1	254	85.3%	31.9	86.2%	32.6	86.1%	32.2	87.0%	32.9
2	357	64.2%	22.5	66.2%	23.3	64.3%	22.6	66.4%	23.4
3	195	37.4%	10.8	39.7%	11.7	37.5%	10.7	39.8%	11.7

note: group 1: reference group, mainly children living with their parents; group 2: singles; group 3: single parents. Simulation 1: actual wages and benefits; simulation 2: Income Support lowered by 10%; simulation 3: reference wages lowered by 10%; simulation 4: combination of the two policies in simulations 2 and 3. The first entry is the participation rate (in %), the second is average desired working hours per week.

In contrast to the simulation with the model of restrictions, the effect of a decrease of the reference wages is not obvious. This policy can pull down wages. For example, we could assume that a decrease of the reference wage by 10 percent will lead to a fall in all actual gross wage rates by 2 percent (see appendix A for a motivation). The labour supply model showed that wages have an impact on desired participation. The negative labour supply effect can compensate the positive employment effect through a lower probability of being restricted. Simulation 3 shows that the positive effect still dominates, except for the lone mothers. The total effect of this policy on participation is smaller compared to the corresponding simulation in section 4. This is specially the case for single females and single mothers, who have a relatively large wage elasticity of participation.

Comparing the decrease of the Income Support in simulation 2 with the decrease of the reference wage in simulation 3, the effect on both actual participation and average realized working hours is strictly larger for the former policy. The Income Support level in the Netherlands is directly connected to the minimum wages. For instance, the social assistance level for a single person is 70 percent of net income earned at the minimum wage. Therefore a decrease of the reference wage, which is related to the minimum wage, should also imply a decrease of the Income Support level. Simulation 4 shows the result of such a policy. The results show that the model works more or less additively with respect to these policies.

6. Conclusions

In this paper, we have estimated labour supply preferences and hours restrictions for singles, lone parents, and children living with their parents, by combining information on actual and desired hours of work. We have used static models, estimated with cross-section data. A crucial assumption is that desired hours in the data are not affected by hours restrictions. This allows separate estimation of the labour supply model. The model for desired hours is fully structural, and fits in the extensive literature on neoclassical static labour supply models. The submodel explaining the restrictions takes preferences and desired hours as given, and uses deviations between actual and desired hours to identify the restrictions. This second part of the model has ad hoc features that could be removed in future work. In particular, the link with the preferences model is very much inspired by computational convenience.

In spite of these shortcomings, the results suggest that using information on desired as well as actual hours is a useful way to attack the traditional identification problem in labour supply models with restrictions. Estimated preferences make sense and yield females' wage elasticities of desired labour supply that are not out of line with findings in the literature based on actual hours. The elasticity estimates appeared to be

Table 8: Elasticities for labour supply (hours per week)

	without restrictions actual hours only		with restrictions actual and desired hours	
	wage	inc.support	wage	inc.support
<u>men</u>				
extra	0.30	-0.33	0.12	-0.15
single	0.36	-0.38	0.15	-0.18
l.parent	0.42	-0.21	0.15	-0.20
<u>women</u>				
extra	0.36	-0.39	0.18	-0.21
single	0.43	-0.49	0.30	-0.37
l.parent	0.88	-0.90	0.81	-0.86

robust with respect to the choice of most auxiliary parameters that determine the specification of the model.

Although evidence on demand restrictions is indirect and incomplete - no information on firms is available - our conclusions about hours restrictions also seem to make sense. In particular, we find that (implicit or explicit) wage thresholds might be a reason for involuntary unemployment.

The natural question comes up whether using desired instead of actual hours makes a difference. For that purpose, we estimated the model of Section 3 using actual hours instead of desired hours. Table 8 compares the elasticities of participation rates and average hours worked for the alternative model (no hours restrictions) with those of our base model in section 3, combined with the model in section 4. The results are based upon calculations similar to those underlying Table 4 for the alternative model, and upon Table 7 for the base model. While the differences for females are quite small, they are substantial for males. For all groups, the model with restrictions taken into account (third and fourth column) gives smaller elasticities than the alternative 'standard' model (first and second column). This corresponds completely to the finding of Ilmakunnas and Pudney (1990).

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Appendix A: Wage formation

This appendix deals with gross hourly wage rates, productivity, and reference wages. The main goal is to get predicted wage rates when the wage rate is unobserved. These predictions are needed in the models of section 3 and 4.

We assume that the gross wage is the Pareto optimal result of a Nash bargaining process in which the productivity of the worker is the threat point of the employer and the reference wage the threat point of the worker. Therefore the gross wage rate will be a weighted average of productivity and reference wage.

Define F as the logarithm of productivity, R as the logarithm of the minimum or reference wage (see below), W as the logarithm of the gross wage. We specify the following equations:

$$F = x'\beta + \epsilon^F \tag{A.1}$$

$$W = b_1 F + (1 - b_1) R \quad \text{if} \quad F \geq R$$

$$W = b_2 F + (1 - b_2) R \quad \text{if} \quad F < R$$

Here x is a vector of individual characteristics, like, for instance, education level dummies and age. If $b_1 = b_2 = 1$ then wage and productivity are equal to each other. An obvious choice would be $0 \leq b_2 \leq b_1 \leq 1$. In principle the parameters b_1 and b_2 can be estimated. This leads to inaccurate estimates because of multicollinearity, however, due to a lack of variation in R independent of x. We therefore do not estimate b_1 and b_2, but assume $b_1 = b_2 = 0.8$. This yields a slightly better fit than models with $b_2 < b_1$.

To take account of possible selectivity bias, we add a "participation" equation, in reduced form:

$$E^* = z'\alpha + \epsilon^P \tag{A.2}$$

The individual works with observed wage rate if and only if $E^* > 0$.

Here z is the vector of variables which influence actual participation. We assume that the distribution of ε^P is standard normal, independent of x and z, and allowed to be correlated with ε^F. Together with the wage equation, this yields a model similar to the Heckman (1979) selection model. We estimate it using Maximum Likelihood.

We have to specify the reference wage. A possible choice would be the official national minimum wage given by law. We will not choose this, because in collective bargaining agreements of many industries, the lowest wages are substantially higher than the national minimum wage. A better choice would be to use the lowest wages of the collective bargains, but unfortunately these are not available in the Socio-Economic Panel. To overcome this problem, we measure the reference wages as the smoothed 10%-quantiles of the wage distribution in certain education and age groups. Here we use the full working subsample of the SEP, including married men and women. The average reference wage is about 60 percent of the average gross wage rate. Reference wages increase with age and education level, but not as much as average wage rates.

Estimation results of equations (A.1) and (A.2) are presented in tables A.1 for men and A.2 for women. For men, the selection has no significant effect. For women it is, somewhat surprisingly, significantly negative. This result was also found by Melenberg and Van Soest (1993).

We are mainly interested in productivity and the gross wage. In equation (A.1) we included some cross products and a third degree polynomial in log age, to make the model flexible. These terms are significant. For men there is no significant difference between the two lowest education levels, while for women this is the case for the three lowest education levels. In general, the wage pattern is as expected: wages increase with education and age. The age pattern is steepest for young people and for the higher educated.

Table A.1: Wages and Participation for men (b_1=b_2=0.8; October 1988)

Parameter estimates with between brackets the standard errors sigma = 0.44 (0.00) rho = -0.11 (0.24)	Participation (A.1)		Productivity (A.2)	
constant	138.64	(39.34)	-76.06	(11.81)
Family characteristics				
single person	-0.91	(0.12)		
single parent	-0.82	(0.39)		
extra category	-0.69	(0.15)		
# children younger 18	0.01	(0.05)		
dummy child younger 6	-0.13	(0.14)		
Human capital				
education level 2	0.13	(0.11)	-0.05	(0.03)
education level 3	0.97	(0.94)	-0.58	(0.28)
education level 4	-0.05	(2.19)	-2.95	(0.34)
education level 5	-0.16	(2.23)	-2.70	(0.35)
log age	-121.86	(33.89)	62.57	(10.12)
$\log^2$ age	36.04	(9.69)	-16.43	(2.87)
$\log^3$ age	-3.54	(0.92)	1.44	(0.27)
ed.l.3: log age	-0.13	(0.26)	0.19	(0.08)
ed.l.4,5: log age	0.25	(0.59)	0.92	(0.09)
Regional factors				
region north	-0.37	(0.16)	-0.16	(0.04)
region east	-0.22	(0.11)	-0.14	(0.02)
region south	-0.10	(0.12)	-0.07	(0.03)
unemployment	0.00	(0.03)	0.01	(0.01)

note: The reference group of the household dummies is the group head or partner. The extra category are the persons who are not head, partner of the head, single or single person. The referencegroup of education is education level 1. Of the regions it is region west.

Table A.2: Wages and Participation for women (b_1=b_2=0.8; October 1988)

Parameter estimates with between brackets the standard errors

sigma = 0.45 (0.01)
rho = -0.33 (0.07)

	Participation equation		Wage equation	
constant	99.01	(34.91)	-109.18	(17.01)
Family characteristics				
single person	0.49	(0.10)		
single parent	-0.12	(0.09)		
extra category	0.31	(0.14)		
# children younger 18	-0.24	(0.03)		
dummy child younger 6	-0.84	(0.07)		
Human capital				
education level 2	0.11	(0.06)	-0.03	(0.04)
education level 3	1.37	(0.65)	0.15	(0.32)
education level 4	0.63	(1.18)	-1.62	(0.57)
education level 5	0.79	(1.20)	-1.26	(0.58)
log age	-90.06	(29.75)	92.20	(14.73)
$\log^2$ age	27.57	(8.41)	-25.18	(4.23)
$\log^3$ age	-2.82	(0.79)	2.29	(0.40)
ed.l.3: log age	-0.25	(0.18)	-0.02	(0.09)
ed.l.4,5: log age	0.01	(0.33)	0.52	(0.16)
Regional factors				
region north	-0.19	(0.09)	-0.10	(0.05)
region east	-0.12	(0.06)	-0.09	(0.03)
region south	-0.17	(0.06)	-0.11	(0.03)
unemployment	-0.01	(0.02)	0.00	(0.01)

note: see Table A.1

Appendix B: Taxes

To determine the budget set of an individual, we assume that the gross wage does not depend on the number of working hours. Thus we can calculate gross labour incomes simply by multiplying the gross wage with the number of hours worked. In our utility maximization model we assume however that individuals consider net incomes. This appendix explains how we compute net income from each possible gross income.

In the data of the Socio-Economic Panel we observe net labour income of almost all working individuals. Using information on family composition, we construct gross labour income inverting the Dutch tax system. In the model of section 3, we need net income for a number of gross incomes for each individual. For computational convenience, we approximate the piecewise linear progressive tax curve by a flexible function, taking full account of the tax free allowance. This leads to the following expression for net income (Y_n) as a function of gross income (Y_g).

$$Y_n = (1-d)\ \alpha_1 Y_g + d \{ \alpha_2 TFA + \alpha_3 (Y_g - TFA) + \alpha_4 \frac{(Y_g - TFA)^2}{10000} \}$$

Here d is a dummy which equals one when the gross income is less than the tax free allowance. The α's are the parameters which we estimate, using observed values of Y_n and values of Y_g, constructed using the exact tax system. α_1 and α_2 are expected to be smaller than one, since the individual pays social security contributions on the tax exempted amount.

OLS results are in Table B.1. Although the Dutch tax system does not discriminate between men and women, the results for both sexes are slightly different. The high R-squares show that the approximation is quite accurate.

In the tax calculations above, other (unearned) income (excluding unemployment benefits and unemployment assistance) was not included. We observe after tax other income from various sources (mainly income from assets and child allowances). We assume that this remains unchanged if the number of working hours changes. Total net income then is the sum of net earnings and net other income. This is an approximation only, since in practice, all taxable sources of individual income are taxed jointly. Since, however, most other income is untaxed child allowances, the approximation error will be small in most cases.

Finally, unemployment assistance benefits are included, as explained in the main text. These are taxed in the same way as earnings.

Table B.1: Results of the tax-model

Parameter estimates with between brackets the standard errors				
Parameters	Men (R^2=.994)		Women (R^2=.997)	
α_1: (1-d)*Y_g	.735	(.048)	.732	(.021)
α_2: d*TFA	.811	(.014)	.779	(.010)
α_3: d*(Y_g-TFA)	.527	(.005)	.573	(.005)
α_4: d*(Y_g-TFA)^2	-.250	(.010)	-.482	(.017)

Appendix C: Sensitivity analysis

The basic model uses IL=8, m=8, TE=112, M=10 and α=2. Tables C.1 and C.2 give the participation rate and labour supply in hours per week. The first row gives them as they are originally in the data, the second after classification with IL=8 and m=8, with labour supply calculated by replacing the exact numbers of working hours by the means of the corresponding cells. The third row gives the results for the basic model, for the other rows one parameter of the basic model is changed.

Table C.1: participation rate in percentage

	men			women		
	child	single	l.parent	child	single	l.parent
data orig.	95.1	90.5	95.0	93.3	70.9	42.6
data clas.	95.1	90.5	95.0	93.3	70.9	42.6
base	94.9	90.3	94.4	92.8	70.3	43.0
IL=10	95.1	90.4	94.1	92.9	70.7	42.9
m=4	95.2	91.1	94.2	93.1	71.3	44.8
TE=98	94.9	90.4	94.4	92.8	70.3	43.0
M=20	94.4	90.5	92.5	92.2	71.6	43.3
α=5	93.9	89.6	94.1	91.8	70.5	44.8
$\alpha=\infty$	95.2	90.1	94.3	93.3	70.6	40.6

Table C.2: labour supply (hours per week)

	men			women		
	child	single	l.parent	child	single	l.parent
data orig.	38.6	35.2	31.9	34.8	24.4	11.3
data clas.	37.8	34.9	31.6	34.6	24.1	10.7
base	37.7	35.0	31.5	34.3	24.1	11.9
IL=10	38.3	35.4	31.3	34.3	24.2	11.9
m=4	37.7	35.0	31.8	34.0	24.0	11.6
TE=98	37.7	35.1	31.6	34.3	24.1	11.9
M=20	37.6	35.0	31.2	34.1	24.5	11.9
α=5	37.3	34.6	31.3	33.8	24.1	12.5
$\alpha=\infty$	37.8	34.9	31.7	34.5	24.2	11.1